

PRELIMINARY REGIONAL ANALYSIS OF THE KAGUYA LUNAR RADAR SOUNDER (LRS) DATA THROUGH EASTERN MARE IMBRIUM. I. Antonenko¹, B.L. Cooper², Y. Yamaguchi³, T. Ono⁴, A. Kumamoto⁴, and G. Osinski¹, ¹Department of Earth Sciences, University of Western Ontario, 1151 Richmond St., London, ON, Canada N6A 5B7, iantonen@uwo.ca, gosinski@uwo.ca, ²NASA/Johnson Space Center/Ocean Engineering Space Systems, 16665 Space Center Blvd, Houston 77058 (281) 686-6821 bonnie.l.cooper@nasa.gov, ³Graduate School of Environmental Studies, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 454-8601, Japan, yasushi@nagoya-u.jp, ⁴Dept. Astro. Geophy., Tohoku Univ., Sendai 980-8578, Japan, ono@stpp1.geophys.tohoku.ac.jp, kumamoto@stpp1.geophys.tohoku.ac.jp.

Introduction: The Lunar Radar Sounder (LRS) experiment on board the *Kaguya* spacecraft is observing the subsurface structure of the Moon, using ground-penetrating radar operating in the frequency range of 5 MHz [1]. Because LRS data provides information about lunar features below the surface, it allows us to improve our understanding of the processes that formed the Moon, and the post-formation changes that have occurred (such as basin formation and volcanism). We look at a swath of preliminary LRS data, that spans from 7 to 72° N, and from 2 to 10° W, passing through the eastern portion of Mare Imbrium (Figure 1). Using software, designed for the mineral exploration industry, we produce a preliminary, coarse 3D model, showing the regional structure beneath the study area. Future research will involve smaller subsets of the data in regions of interest, where finer structures, such as those identified in [2], can be studied.

Data: The data is provided in a series of tracks that run approximately north-south, over a wide range of latitudes (Figure 1). Each track provides a cross-section, representing the strengths of reflectors. Figure 2 shows one such cross section, transecting Kirch crater in Mare Imbrium. Figure 3 shows the ground track for this cross section. Note, this data is fairly preliminary, since noise, reflection parabolas, and possible instrument artifacts can still be seen in cross sections. Work is underway to correct such processing issues.

Procedure: Over 55 million data points were compiled and gridded into a 3-dimensional model of the region (Figure 4). The resolution of this model is

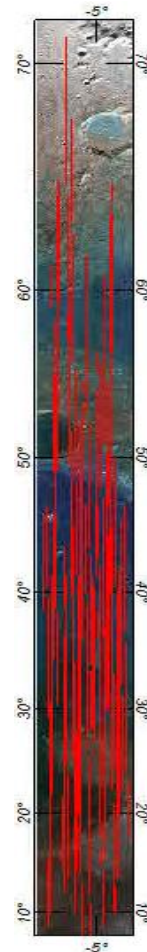


Figure 1. Clementine image of study area, overlain by ULCN2005 DEM data. Red lines show ground tracks for the LRS data used.

fairly coarse, corresponding to 2° of latitude/longitude, and 2 time-delay units (TDU) per volume element (voxel). As a result, many of the artifacts seen in Figure 2 are smoothed away. We estimate that each time-delay unit (TDU) from the radar returns corresponds roughly to 6.3 m in rock. Thus, our vertical resolution (at ~13 m/voxel) is substantially better than our horizontal resolution (~60,000 m/voxel). Our TDU estimate was also used to obtain the depth values on the left of Figure 2.

Results: We have observed that topography is very readily identified in the data and locations of topographic features appear to correspond well with previous data. This is illustrated in Figures 2 and 3, where topographic highs in the LSR profile are correlated to surface features identified in Clementine images and DEM.

Despite low resolution, our 3D voxel grid highlights a variety of structural features. For example, the column of lime and green voxels, located at 11° Latitude, corresponds to the Apennine Mountains at the

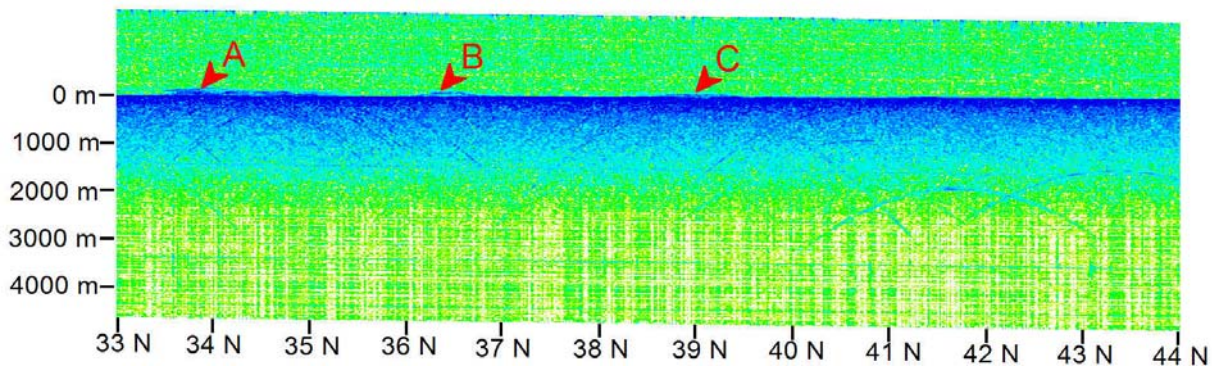


Figure 2. Sample LRS cross-section in eastern Mare Imbrium. Ground track for this section is shown in Figure 3.

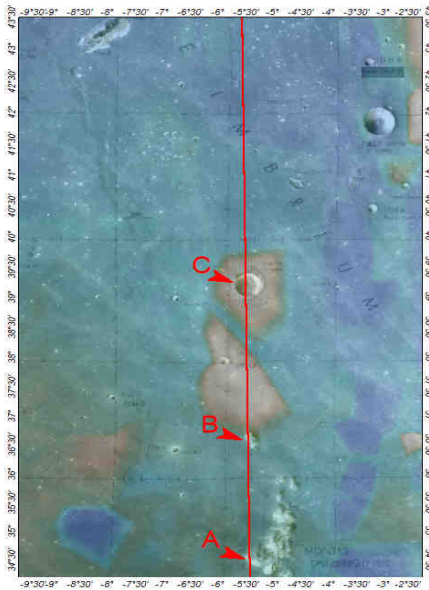


Figure 3. Ground track for Figure 2 profile data. Track bisects Kirch crater (arrow C), located at the image centre. Red pointers correspond to those in Figure 2.

south-east edge of the Imbrium basin. As a result, we can see what appears to be the edge of Imbrium basin. Interestingly, the Alpes Mountains at Imbrium's northern boundary are not distinctly evident in this model.

There appears to be a distinct boundary at about 600 TDU (~ 3.8 km) that dips sharply beneath Archimedes crater (to < 4.4 km). The precise depth of this boundary is hard to pin-point, because its exact loca-

tion moves slightly as we vary our colour palate. Despite this, there does seem to be a consistent structure, with a sub-horizontal character at ~ 3.8 km depth in the north, and a dip to ~ 4.4 km in the Archimedes crater region. Since Archimedes crater is too small (84 km) to affect the overall stratigraphy to such depths, some other process must be responsible. Potential candidates include an earlier and larger impact event, subsidence due to mare loading, or possibly a higher concentration of basaltic dikes at this location.

There is a more distinct boundary, located at ~ 1000 TDU (6.3 km). The position of this boundary does not vary with colour palette, so we can be more confident in its precise placement. Its depth is somewhat consistent with maximum depth estimates for Mare Imbrium [3]. However, because it does not vary under the highland areas, it is more likely to represent the limits of detection for the instrument. In that case, the features beneath are simply noise artifacts.

Conclusions: LRS data provides opportunities to study the sub-surface of the Moon. Even at low resolutions, regional 3D models give insights into large-scale structures. Future work will focus on identified areas of interest, using higher resolution models.

References: [1] Ono, T. and H. Oya (2000) *Earth Planets & Space*, 52, 629-638. [2] Cooper, B. *et al*, (2008) *NLSI Lunar Science Conference (2008)*, Abstract #2060. [3] Head, J.W. (1976) *R. Geophys. & Space Phys.*, 14, 265-300.

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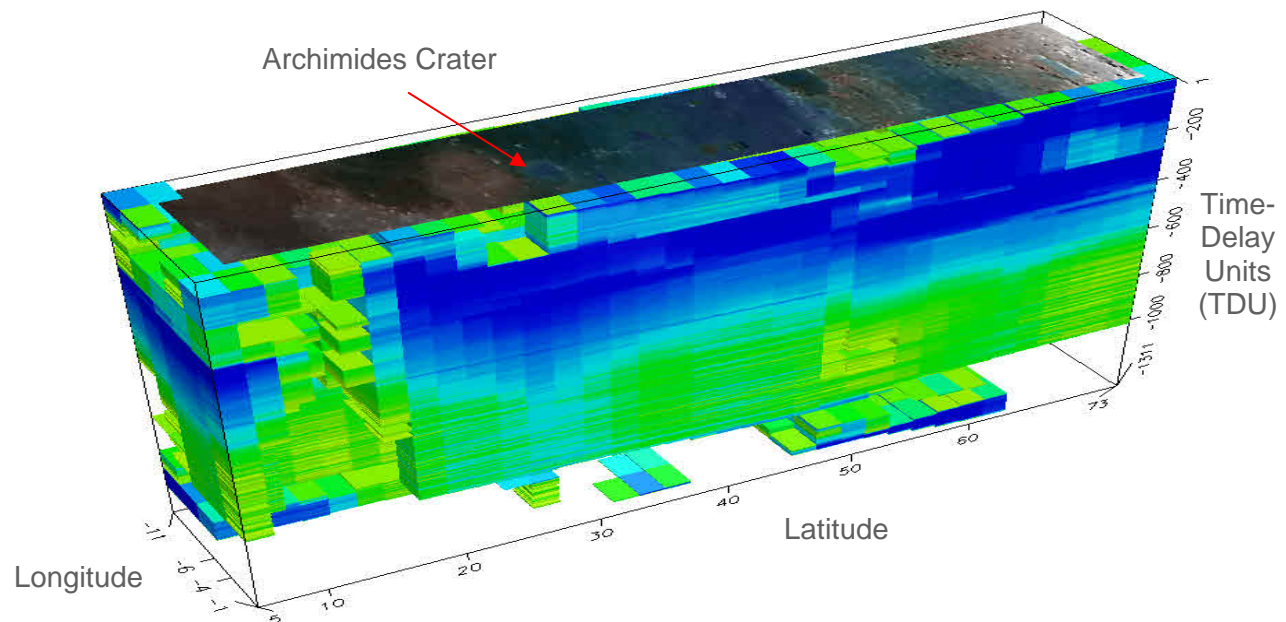


Figure 4. Voxel grid of all the LRS data in our study region. Deep blue colours represent strong reflectors, while light green colours represent medium reflectors. Weak reflectors ($DN > 125$) are not displayed on this image. Despite the coarse resolution, large structural features can be seen. The image from Figure 1 (minus the ground tracks) is placed at the top of the grid, for reference.